



INVESTIGATOR'S ANNUAL REPORT

United States Department of the Interior
National Park Service

All or some of the information you provide may become available to the public.

OMB # (1024-0236)
Exp. Date (11/30/2010)
Form No. (10-226)

Reporting Year: 2008	Park: Shenandoah NP	Select the type of permit this report addresses: Scientific Study	
Name of principal investigator or responsible official: Rebecca Forkner		Office Phone: (703) 993-4683	
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Project Title (maximum 300 characters): Phenological Changes in Insects and Plant Phenolics Along Altitude Gradients			
Park-assigned Study or Activity #: SHEN-00355	Park-assigned Permit #: SHEN-2008-SCI-0016	Permit Start Date: Jul 17, 2008	Permit Expiration Date: Dec 31, 2011
Scientific Study Starting Date: Jul 17, 2008		Estimated Scientific Study Ending Date: Dec 31, 2008	
For either a Scientific Study or a Science Education Activity, the status is: Continuing		For a Scientific Study that is completed, please check each of the following that applies: <input type="checkbox"/> A final report has been provided to the park or will be provided to the park within the next two years <input type="checkbox"/> Copies of field notes, data files, photos, or other study records, as agreed, have been provided to the park <input type="checkbox"/> All collected and retained specimens have been cataloged into the NPS catalog system and NPS has processed loan agreements as needed	
Activity Type: Research			
Subject/Discipline: Plant Communities (Vegetation)			

Purpose of Scientific Study or Science Education Activity during the reporting year (maximum 4000 characters):

Preliminary research indicated that cumulative temperature before leaf fall explained less than 50% of color change (phenolic chemicals) and alone wasn't sufficient to forecast onset of leaf coloring. The goal of our project is to answer several questions regarding the multiple roles of phenolics in order to forecast changes in autumn leaf color due to global warming. First, we will quantify the degree to which individual stressors (insects, UV-B radiations) alter phenolic concentrations. Next, we will quantify how stressors alter phenolics at different plant developmental stages. Also, we will determine the degree to which changes in phenolics at different developmental stages are related. Lastly, we will determine the relationship between concentrations and visual expression. We will 1) Monitor timing of leaf flush and fall, 2) Measure insect abundance and leaf damage 3 times during the season, 3) Collect leaf material for assays of phenolics 4 times during the season: immediately after leaf flush, mid summer after leaves mature, end of summer prior to chlorophyll degradation, and at peak color change, 4) Quantify leaf color change, 5) Monitor temperature variation to

calculate degree day accumulation (DDA) and relate it to leaf flush, fruiting, insect activity, leaf fall, and color change, 6)
Experimentally alter leaf damage and UV levels in a factorial experiment.

Findings and status of Scientific Study or accomplishments of Science Education Activity during the reporting year (maximum 4000 characters):

Research sites were established in high altitude location near Mathews Arm campground and Keyser Run trails. Experimental leaf damage treatments were completed by late July; therefore, spring leaf budburst information was not collected in this season. Likewise, UV treatments were not undertaken. However, gypsy moths (*Lymantria dispar*) destroyed our study plants at Mathews Arm, and additional site were established at Elkwallow and Brown Town trails in order to account for this effect. Leaf material was collected only once (in late September/early October) from all 4 locations for phytochemical analysis.

Leaves on understory saplings in areas damaged by *L. dispar* retained more leaves at the beginning of autumn leaf drop in late September/early October, but amounts of abscised leaves did not appear to differ at peak leaf color change in mid-October (date \bar{A} damage, $F = 7.204$, $P = 0.009$). Moreover, leaves on saplings in damaged areas showed a lower degree of color change at both survey dates (damage, $F = 6.595$, $P = 0.013$; date, $F = 243.81$, $P < 0.0001$).

Preliminary results suggest that insect stressors, specifically damage by Gypsy moths, will reduce the expression of visible anthocyanidin pigments in *A. rubrum* and *Q. alba*, slow the timing of leaf abscission, and lead to less vibrant autumn foliar displays within the Shenandoah National Park. The observed slower rates of leaf abscission of saplings in *L. dispar* damaged sites contradicts other research showing earlier leaf abscission of damage leaves, although both studies suggest negative impacts of Gypsy moths on the vibrancy of autumn leaf color. Previous studies did not examine leaf abscission on trees with re-flush foliage, and it is possible that phenology and chemistry of saplings having newly produced leaves differs from damaged trees that do not re-flush leaves. Additionally, saplings in Gypsy moth damaged areas may have had higher amounts of foliar nitrogen as a result of a high influx of Gypsy moth frass, and more brilliant displays of color are associated with lower levels of leaf nitrogen. Future studies will incorporate a larger number of damaged and undamaged sites, include recently damaged areas and areas damaged during the 1995 and 2001 outbreaks of *L. dispar*, compare experimentally damage to undamaged trees and trees with re-flushed foliage.

Because some anthocyanidins and other phenolic compounds that defend plants against insects are colorless compounds, we will need to complete chemical analyses before drawing conclusions about the role of *L. dispar* in overall resource re-allocation within plants. Likewise, next season, we will begin collection of leaf flush and fruiting in damaged and undamaged locations.

For Scientific Studies (not Science Education Activities), were any specimens collected and removed from the park but not destroyed during analysis?

No

Funding specifically used in this park this reporting year that was provided by NPS (enter dollar amount):
\$0

Funding specifically used in this park this reporting year that was provided by all other sources (enter dollar amount):
\$1700

List any other U.S. Government Agencies supporting this study or activity and the funding each provided this reporting year:

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